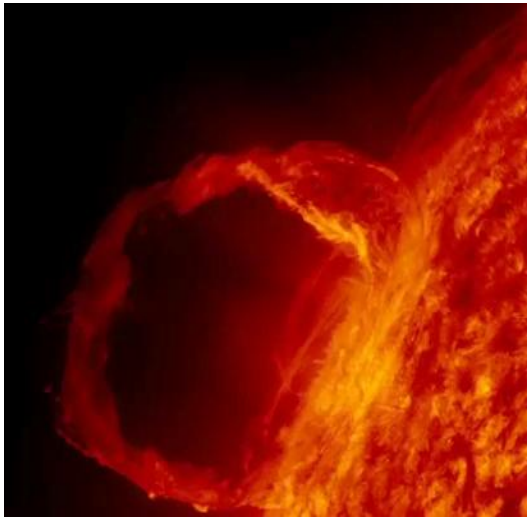
Four-Year Plan for WMO Coordination of Space Weather Activities

Terry Onsager (NOAA Space Weather Prediction Center,
Co-Chair WMO/ICTSW)

Jérôme Lafeuille (WMO Space Programme Office)

Main Topics



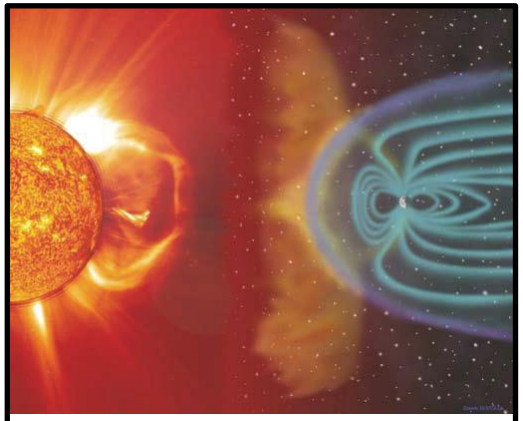
- WMO and Space Weather
- Initial WMO achievements in Space Weather
- Plans for the next four years and beyond

World Meteorological Organization

Specialized Agency of the United Nations with 185 Member States

The specialized United Nations agency for meteorology (weather and climate), operational hydrology and related geophysical sciences.

- Space weather is consider a “related geophysical science”



Report on: THE POTENTIAL ROLE OF WMO IN SPACE WEATHER

April 2008

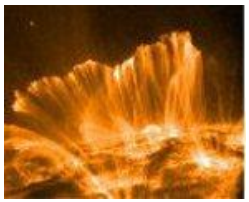
WMO Space Programme:

Space-based Observing System

Access to Satellite Data and Products

Awareness and Training

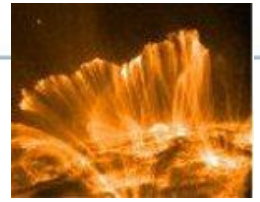
Space Weather Coordination



WMO Space Weather Goals

- Promote the sustained availability and interoperability of essential observations
- Improve the collection and delivery of space weather information
- Facilitate transfer of scientific advances to operational services
- Identify user requirements and develop best practices, to support the establishment of high-value services, focusing where international coordination is required, such as aviation
- Improve emergency warning procedures and global preparedness
- Support training and capacity building
- Promote synergy between the space weather, meteorology, and climate communities

Space Weather Coordination



Space-based Observing System

Access to Satellite Data and Products

Awareness and Training

WMO Inter-Programme Coordination Team on Space Weather (ICTSW)

Established in May, 2010

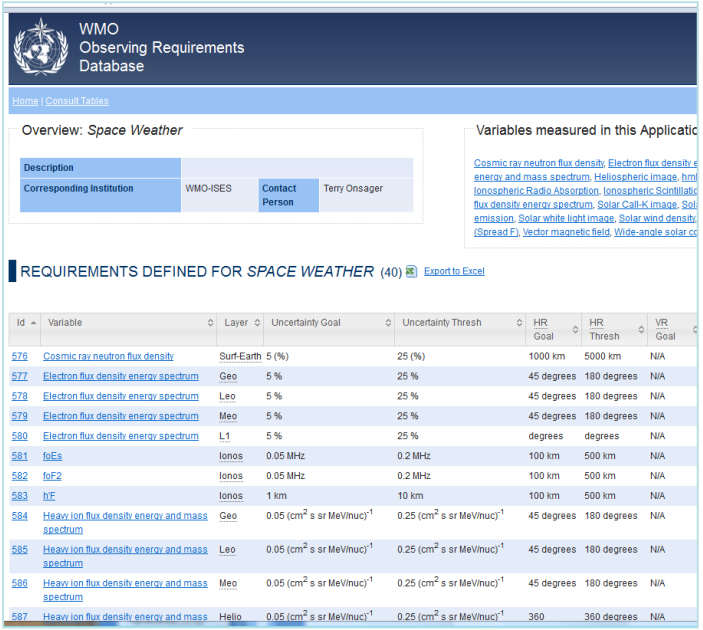
Joint leadership: Commission for Basic Systems & Commission for Aeronautical Meteorology

24 out of 185 WMO Member States

7 International Organizations

International Space Weather Observing Requirements

- Observing requirements are documented.
- Updated on two-year cadence by international team
- Database addresses operational, research, and climatology needs
- Forms the basis for gap analysis and advocacy



WMO
Observing Requirements
Database

Home | Consult Tables

Overview: *Space Weather*

Description			
Corresponding Institution	WMO-ISES	Contact Person	Terry Onsager

Variables measured in this Applicatic

Cosmic ray neutron flux density, Electron flux density e
energy and mass spectrum, Heliospheric image, hml
Ionospheric Radio Absorption, Ionospheric Scintillatic
flux density energy spectrum, Solar CaII-K image, Sol
emission, Solar white light image, Solar wind density
(Spread F), Vector magnetic field, Wide-angle solar co

REQUIREMENTS DEFINED FOR *SPACE WEATHER* (40) Export to Excel

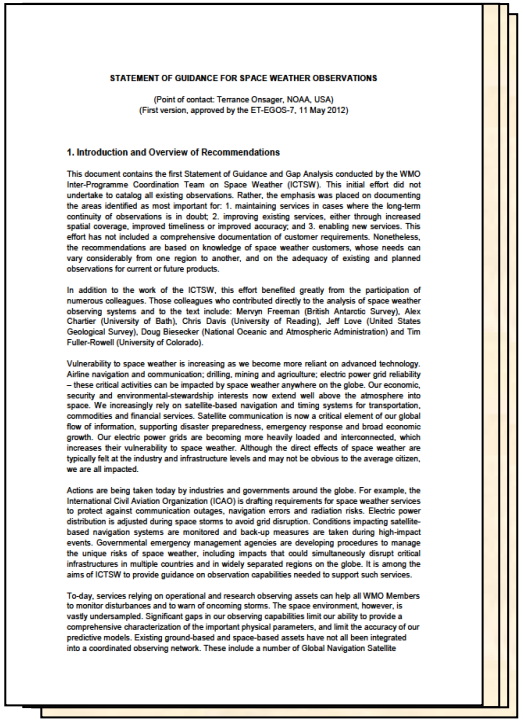
Id	Variable	Layer	Uncertainty Goal	Uncertainty Thresh	HR Goal	HR Thresh	VR Goal
576	Cosmic ray neutron flux density	Surf-Earth	5 (%)	25 (%)	1000 km	5000 km	N/A
577	Electron flux density energy spectrum	Geo	5 %	25 %	45 degrees	180 degrees	N/A
578	Electron flux density energy spectrum	Leo	5 %	25 %	45 degrees	180 degrees	N/A
579	Electron flux density energy spectrum	Meo	5 %	25 %	45 degrees	180 degrees	N/A
580	Electron flux density energy spectrum	L1	5 %	25 %	degrees	degrees	N/A
581	foEs	Ionos	0.05 MHz	0.2 MHz	100 km	500 km	N/A
582	foF2	Ionos	0.05 MHz	0.2 MHz	100 km	500 km	N/A
583	hF	Ionos	1 km	10 km	100 km	500 km	N/A
584	Heavy ion flux density energy and mass spectrum	Geo	0.05 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	0.25 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	45 degrees	180 degrees	N/A
585	Heavy ion flux density energy and mass spectrum	Leo	0.05 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	0.25 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	45 degrees	180 degrees	N/A
586	Heavy ion flux density energy and mass spectrum	Meo	0.05 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	0.25 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	45 degrees	180 degrees	N/A
587	Heavy ion flux density energy and mass	Helio	0.05 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	0.25 $(cm^2\ s\ sr\ MeV/nuc)^{-1}$	360	360 degrees	N/A

http://www.wmo-sat.info/oscar/applicationareas/view/25

WMO Space Weather Observations Gap Analysis (Statement of Guidance)

- Addresses observing needs for:
  - Long lead-time forecasts
  - Alerts of hazardous conditions
  - Event climatology
  - Model validation
  - Scientific research
- Observing domains:
  - Ionosphere
  - Thermosphere
  - Geomagnetic
  - Energetic Particles
  - Solar and Interplanetary

Statement of Guidance for Space Weather Observations



STATEMENT OF GUIDANCE FOR SPACE WEATHER OBSERVATIONS

(Point of contact: Terrance Onsager, NOAA, USA)
(First version, approved by the ET-EGOS-7, 11 May 2012)

1. Introduction and Overview of Recommendations

This document contains the first Statement of Guidance and Gap Analysis conducted by the WMO Inter-Programme Coordination Team on Space Weather (ICTSW). This initial effort did not undertake to catalog all existing observations. Rather, the emphasis was placed on documenting the areas identified as most important for: 1. maintaining services in cases where the long-term continuity of observations is in doubt; 2. improving existing services, either through increased spatial coverage, improved timeliness or improved accuracy; and 3. enabling new services. This effort has not included a comprehensive documentation of customer requirements. Nonetheless, the recommendations are based on knowledge of space weather customers, whose needs can vary considerably from one region to another, and on the adequacy of existing and planned observations for current or future products.

In addition to the work of the ICTSW, this effort benefited greatly from the participation of numerous colleagues. Those colleagues who contributed directly to the analysis of space weather observing systems and to the text include: Mervyn Freeman (British Antarctic Survey), Alex Chartier (University of Bath), Chris Davis (University of Reading), Jeff Love (United States Geological Survey), Doug Biesecker (National Oceanic and Atmospheric Administration) and Tim Fuller-Rowell (University of Colorado).

Vulnerability to space weather is increasing as we become more reliant on advanced technology. Airline navigation and communication; drilling, mining and agriculture; electric power grid reliability – these critical activities can be impacted by space weather anywhere on the globe. Our economic, security and environmental-stewardship interests now extend well above the atmosphere into space. We increasingly rely on satellite-based navigation and timing systems for transportation, commodities and financial services. Satellite communication is now a critical element of our global flow of information, supporting disaster preparedness, emergency response and broad economic growth. Our electric power grids are becoming more heavily loaded and interconnected, which increases their vulnerability to space weather. Although the direct effects of space weather are typically felt at the industry and infrastructure levels and may not be obvious to the average citizen, we are all impacted.

Actions are being taken today by industries and governments around the globe. For example, the International Civil Aviation Organization (ICAO) is drafting requirements for space weather services to protect against communication outages, navigation errors and radiation risks. Electric power distribution is adjusted during space storms to avoid grid disruption. Conditions impacting satellite-based navigation systems are monitored and back-up measures are taken during high-impact events. Governmental emergency management agencies are developing procedures to manage the unique risks of space weather, including impacts that could simultaneously disrupt critical infrastructures in multiple countries and in widely separated regions on the globe. It is among the aims of ICTSW to provide guidance on observation capabilities needed to support such services.

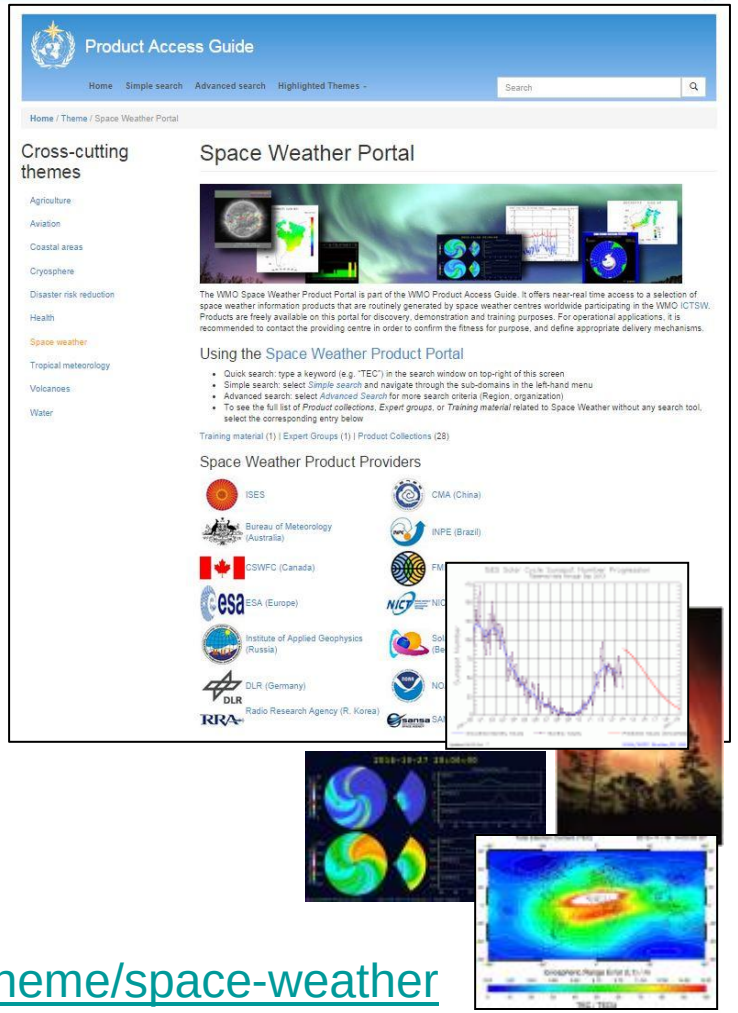
To-day, services relying on operational and research observing assets can help all WMO Members to monitor disturbances and to warn of oncoming storms. The space environment, however, is vastly undersampled. Significant gaps in our observing capabilities limit our ability to provide a comprehensive characterization of the important physical parameters, and limit the accuracy of our predictive models. Existing ground-based and space-based assets have not all been integrated into a coordinated observing network. These include a number of Global Navigation Satellite

http://www.wmo.int/pages/prog/www/OSY/SOG/SoG-SW.doc

WMO Space Weather Product Portal

Ten countries now contribute space weather products on the portal

- Enhance awareness of available products
- Near real-time use at no cost enabling demonstration in operational context
- Increase global participation in space weather services
- Facilitate intercomparison and coordination of products
- Training module under development for new users

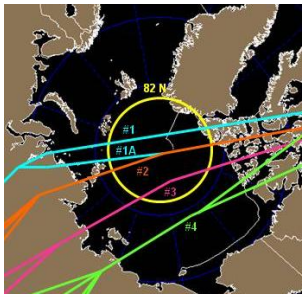


http://www.wmo-sat.info/product-access-guide/theme/space-weather

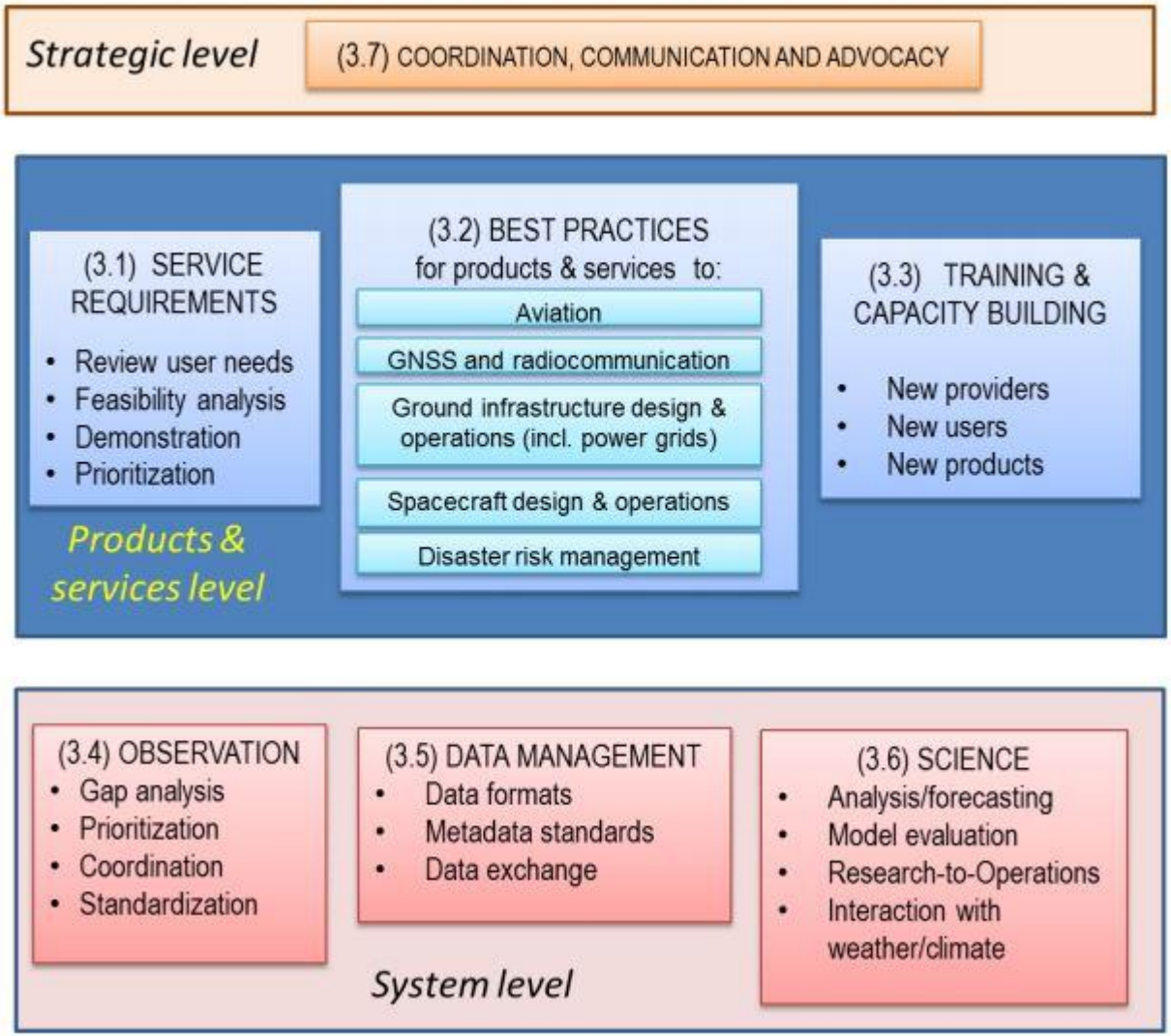
Coordination of Major Application Areas: Aeronautical Meteorology

ICAO recognizes the ICTSW (as a technical body supporting the WMO CAeM) to provide advice on space weather matters

- Reviewed the ICAO Concept of Operation for International Space Weather Information
- Reviewed draft Standards and Recommended Practices on space weather
- Provided guidance on future organization of operational space weather service delivery

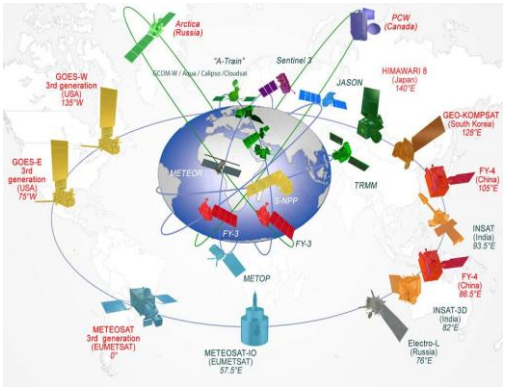


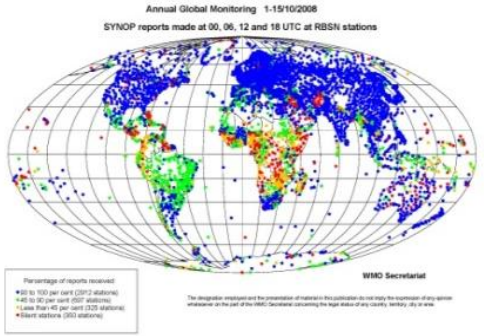
Four-Year Plan for WMO Coordination of Space Weather Activities *(Submitted to WMO Congress, May 2015)*



Systems Level Activities

- Coordinate observational assets and plans to ensure interoperability and continuity of space weather observations
- Take advantage of integration of meteorological and space weather observations where relevant
- Support information exchange through the WMO Information System (WIS) framework, standards, practices, policies
- Dialogue with meteorological/climate community on modeling and verification





Service Level Activities

- Organize WMO Members to deliver coordinated services responding to ICAO requirements
- Prepare for extreme events in a multi-hazard Disaster Risk Reduction approach
- Analyze requirements for applications including ionospheric disturbances (radio propagation and GNSS), satellites, and ground infrastructure (power grids)
- Provide training on delivery and use of services

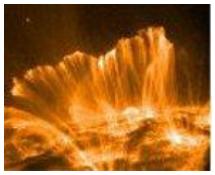
Strategic Level Activities

- Build on:
  - Partnership with service providers (ISES)
  - Observations providers (e.g., INTERMAGNET, CGMS)
  - Scientific organizations (e.g., COSPAR)
  - User organizations (e.g., ICAO and ITU)
  - Capacity building initiatives (e.g., ISWI)
  - Overall UN space policy framework (COPUOS)
- Emphasize synergy with core WMO activities
- Support involvement of additional WMO Members
- Focus on achievable priority objectives for 2016-2019
- Pave the way for long-term sustained activity

Examples of First Priority Actions

- Support ICAO working groups on requirements for aviation services
- Survey applications sections where international coordination of services is required
- Establish real-time coordination for extreme events
- Identify organizations that wish to establish space weather service delivery and define training objectives
- Conduct training sessions and provide tutorial tools
- Update space weather observing requirements and gaps
- Identify essential data and products for exchange on the WMO Information System

Space Weather Coordination

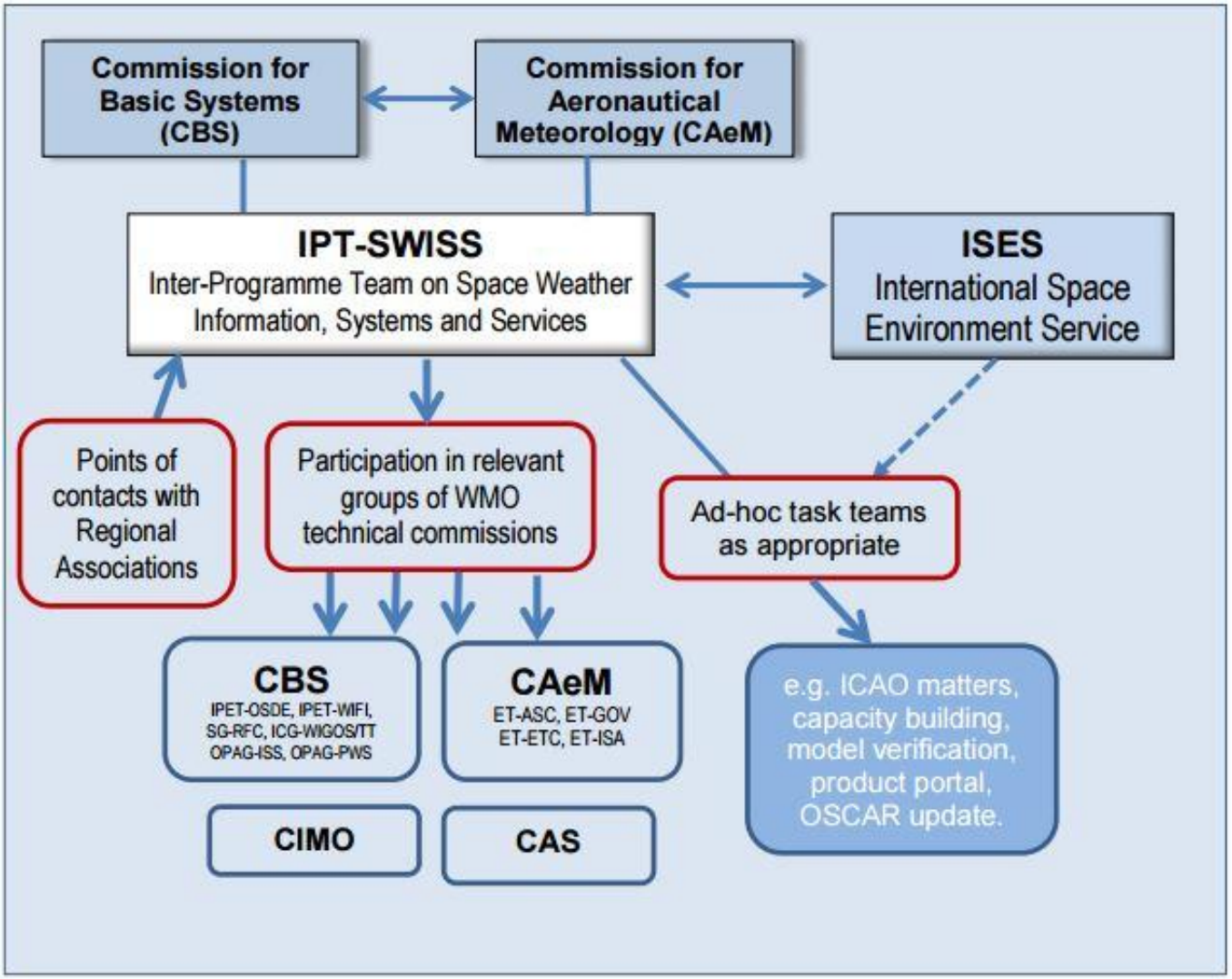


Space-based Observing System

Access to Satellite Data and Products

Awareness and Training

Proposed Organization of WMO Space Weather Activities



Summary

- There is a growing, global need for improved services and for consistent, coordinated observations and operational information
- The WMO is now actively engaged in defining observing requirements, observing gaps, and service needs and in coordinating efforts
- The four-year plan for space weather:

  - Builds on prior accomplishments and current efforts

  - Promotes synergy with WMO core programs in meteorology and climate

  - Fosters coordination with service, research, and policy organizations

  - Identifies specific actions to achieve the identified goals

- Interagency and international participation is encouraged in all aspects of this effort